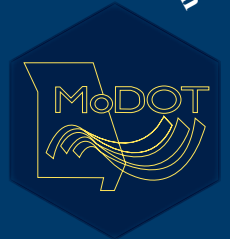


Human Resources - Employee Development
P.O. Box 270
Jefferson City, MO 65101

May 5, 2006

Truck Mounted Attenuators

Missouri Department of Transportation



TMA Training

May 5, 2006

Employees Name: _____ Building: _____

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Introduction to Truck Mounted Attenuators (TMA's)

The Need for Training

As the driver of a truck-mounted attenuator vehicle, your job is one of the most important on the crew. You are responsible for making sure that all other employees are adequately protected from errant vehicles in or around a work zone. It is the goal of MoDOT to provide consistent use of TMA's statewide.

Truck-mounted attenuators are designed to absorb the energy of an errant vehicle. Your job is to make sure that you are in the proper location, provide ample roll-ahead distance, and adequate warning to your co-workers and traveling public, when applicable.

Training

All employees that drive a truck-mounted attenuator (TMA) will be trained in the proper methods of installation, transporting, setup, operations, and preventative maintenance of the unit. To ensure that an employee understands his/her responsibility, every operator must successfully demonstrate the proper methods of attaching a TMA to a truck and perform operational and preventative checks and maintenance on the unit.

Course Objectives

After completing this training, you should be able to understand the following:

- ✓ Qualifications of the TMA driver
- ✓ Your responsibility as a TMA/crash truck driver
- ✓ The NCHRP test(s) and recognize the importance of them
- ✓ The roll of a protective vehicle and define its purpose
- ✓ The roll-ahead distance and when you should adjust those distances

Notes:

A protective vehicle shall be used while work is in progress. The protective vehicle shall be equipped with a TMA and flashing arrow panel and positioned at least 150 feet in the advance warning area of the workspace. The protective vehicle may be eliminated if the roadway is posted at 45 mph or below. The work vehicle is equipped with a flashing arrow panel and uses activated rotating lights and strobe lights.

If the TMA is in a stationary operation, the wheels should be aligned with traffic and the truck should be in neutral with the parking brake set.

In mobile operations, the TMA truck operator should be positioned at least 150 feet in the advance warning area of the workplace and observant to all surrounding conditions. The wheels should be aligned with the traffic.

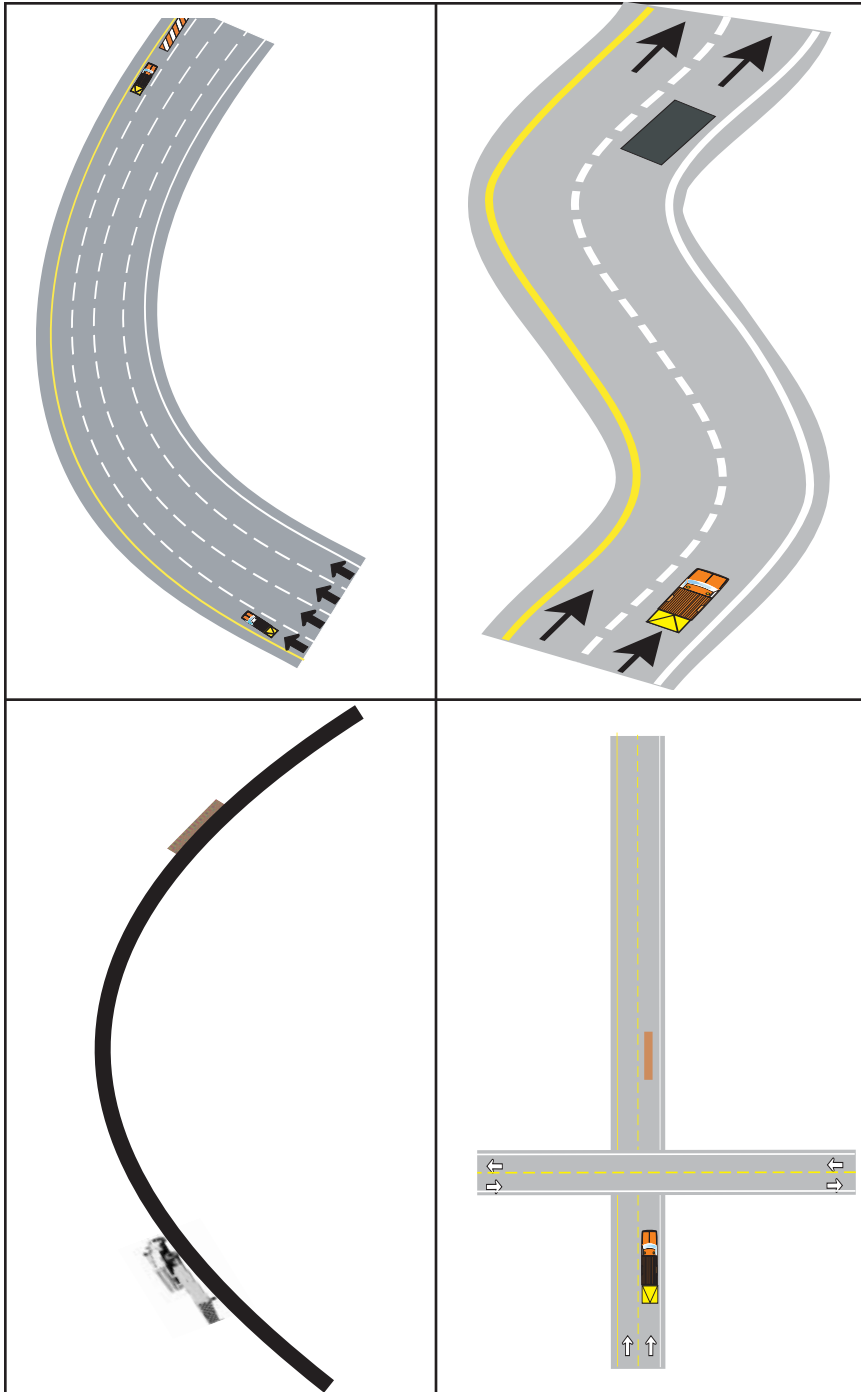
When working on hills, curves, or areas where sight distances may occur, the TMA operator should be far enough back to allow motorist to see that work is being performed and that they should proceed with caution. It is recommended that another protective vehicle be placed close to the work space to eliminate errant vehicles from re-entering the lane where work is taking place.

Where bridges, overpasses, or the sight distance restrictions are presented, the protective vehicle or TMA should stay behind the obstacle until the work has progressed past the blind spot.

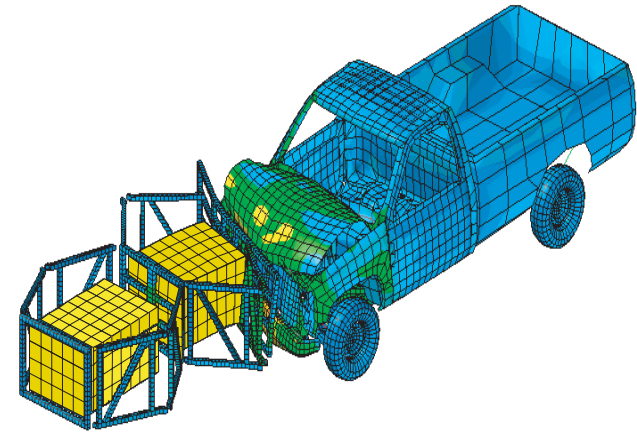
An additional protective vehicle or TMA truck should be considered closer to the work space to keep errant vehicles from re-entering the work space.

Horizontal and Vertical Curves with Geometric Obstructions

Scenario 7



- ✓ MoDOT's policy on equipment usage in the cab while the truck is in operations
- ✓ Installation, removal, and performance of preventative maintenance on a TMA
- ✓ State the difference between stationary and mobile TMA operations



Section I – Driver Characteristics

Qualifications of a TMA Driver

1. Be trained in TMA operations and procedures
2. Be alert, aware, observant, and able to react to surrounding conditions
3. Be familiar with daily tasks and be able to apply appropriate typical applications



The Responsibility of a TMA Driver

It is the responsibility of the driver to make sure crew members are protected from the traveling public. The driver needs to be alert, attentive, and observant to the surrounding conditions. The driver should be able to constantly check his/her mirrors and be able to communicate effectively with the crew members.

Crashworthy Devices

NCHRP stands for: *National Cooperative Highway Research Project*

NCHRP has two different types of crashworthy TMA devices:

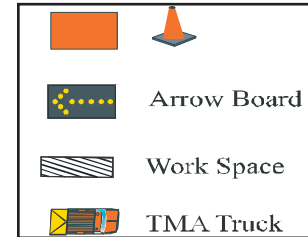
- 1.) NCHRP 230 was first done on a small compact car at 45 mph on lower volume routes.
- 2.) In 1999, NCHRP 350 was developed to increase crashworthy devices for vehicles on routes that are designated for 62 mph or greater. This test was performed using a TMA and a 1/2-ton vehicle.

MoDOT is actively working to have all new NCHRP 350 TMAs on high-volume routes prior to 2008. NCHRP 230 TMAs are still adequate and will continue to be used on lower volume and lower speed routes. They have been proven to be a great tool to help protect employees as well as the traveling public.

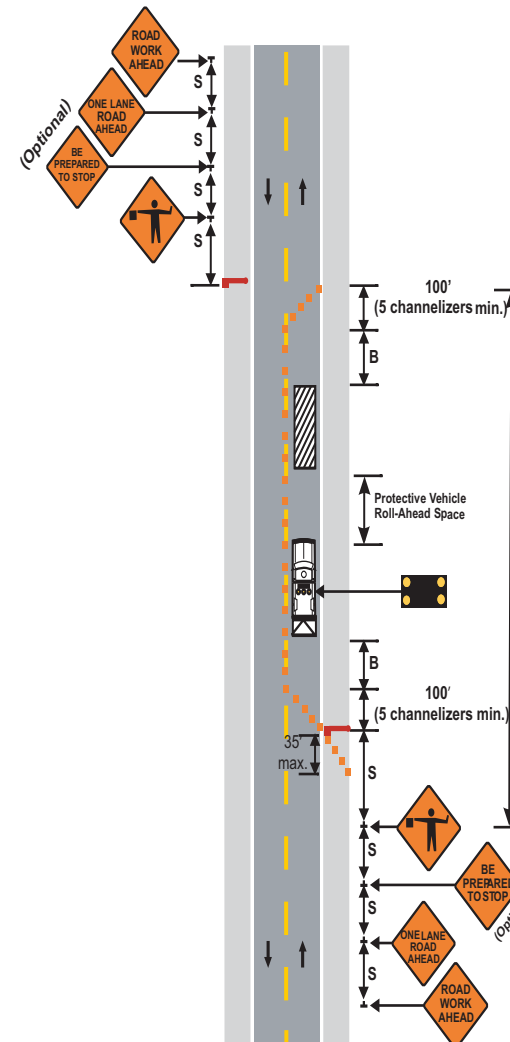
The tests were performed in a straight-on-collision and an offset-collision

Lane Closure on Two-lane Highways Using Flaggers

Scenario 6



Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-Lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Recommended	Recommended
Multi-lane Divided	Required	Required	Recommended



Note:

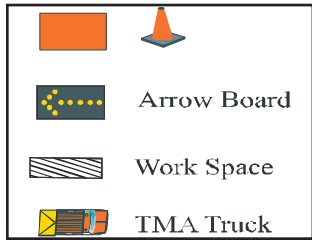
A protective vehicle shall be used while work is in progress. The protective vehicle shall be equipped with a TMA and flashing arrow panel and positioned at least 150 feet in the advance warning area of the workspace. The protective vehicle may be eliminated if the roadway is posted at 45 mph or below. The work vehicle is equipped with a flashing arrow panel and uses activated rotating lights and strobe lights.

If the TMA is in a stationary operation, the wheels should be aligned with traffic and the truck should be in neutral with the parking brake set.

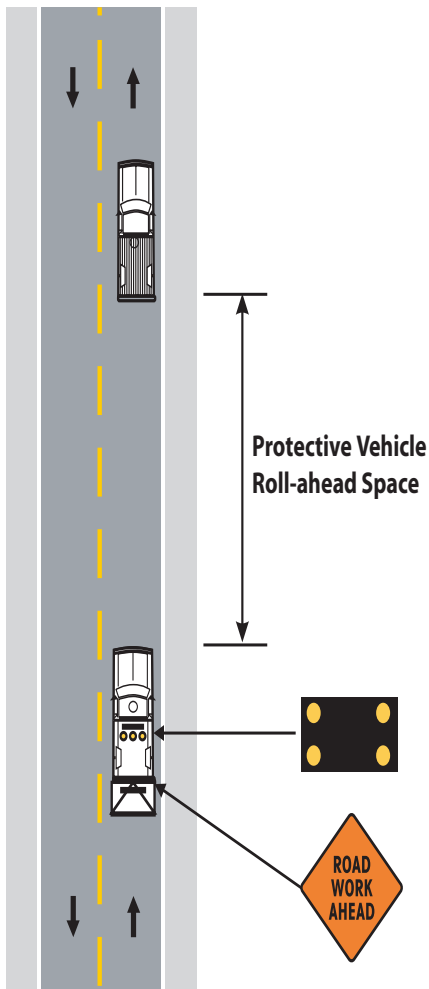
In mobile operations, the TMA truck operator should be positioned at least 150 feet in the advance warning area of the workplace and observant to all surrounding conditions. The wheels should be aligned with the traffic.

Mobile Operation on Two-lane Highways

Scenario 5



Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-Lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Recommended	Recommended
Multi-lane Divided	Required	Required	Recommended

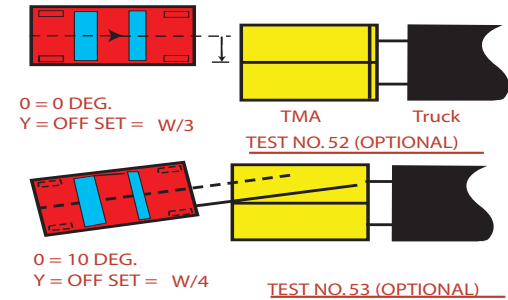


Note:

A protective vehicle shall be used while work is in progress. The protective vehicle should be equipped with a TMA and flashing arrow panel and positioned at least 150 feet in the advance warning area of the workspace. The protective vehicle may be eliminated if the roadway is posted at 45 mph or below. The work vehicle is equipped with a flashing arrow panel and uses activated rotating lights and strobe lights.

If the TMA is in a stationary operation, the wheels should be aligned with traffic and the truck should be in neutral with the parking brake set.

In mobile operations, the TMA truck operator should be positioned at least 150 feet in the advance warning area of the workplace and observant to all surrounding conditions. The wheels should be aligned with the traffic.



Important Note - NCHRP 350 crash tests were conducted on a 3/4 standard cab pickup. Vehicles larger than a standard cab pickup such as large SUVs, freight trucks, or semi's weight more and require a greater stopping distance. TMA drivers should consider greater roll-ahead distance if conditions warrant.

A protective vehicle is defined as a vehicle used to protect workers or work equipment from errant vehicles.

Protective vehicles are used to safeguard the work space from errant vehicles. In some operations, these devices also serve as platforms for signs and other devices used to warn traffic of upcoming conditions or inform them of needed actions. For increased motorist, driver, and worker safety, the protective vehicle may be equipped with a truck-mounted attenuator as noted in the following section.

Protective vehicles should provide sufficient warning to approaching traffic and maximum protection to workers and equipment. This implies the protective vehicle be positioned so that it is clearly visible to approaching traffic, minimizes any vehicular encroachment into the area between the protective vehicle and the work space, and maintains a recommended minimum of 150-foot clear roll ahead distance between the vehicle and the work space.



The wheels of the protective vehicle should be aligned with traffic at all times. In addition, the emergency brake shall be set and the transmission put into neutral in stationary operations.

Reaction Time

While you are operating a TMA truck, your job is to protect the crew and yourself. If you notice an errant vehicle coming towards your TMA truck, you should try to alert the crew and proceed forward to lessen the impact.

Note: If you do drive forward to lessen the impact, you should be observant of all crew workers and try to maintain at least 150 roll-ahead distance. In instance where you do not have the recommended 150 roll-ahead distance, DO NOT roll forward to lessen the impact.

Truck-Mounted Attenuators

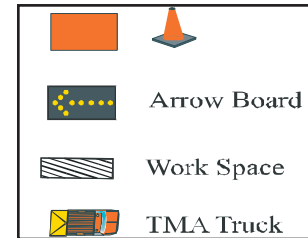
Truck mounted attenuators are energy absorbing devices attached to the rear of trucks used as protective vehicles. These devices are designed to protect the motorist and protect the vehicle's driver upon impact.

In general, the guidelines for the use of these devices are shown in the following table:

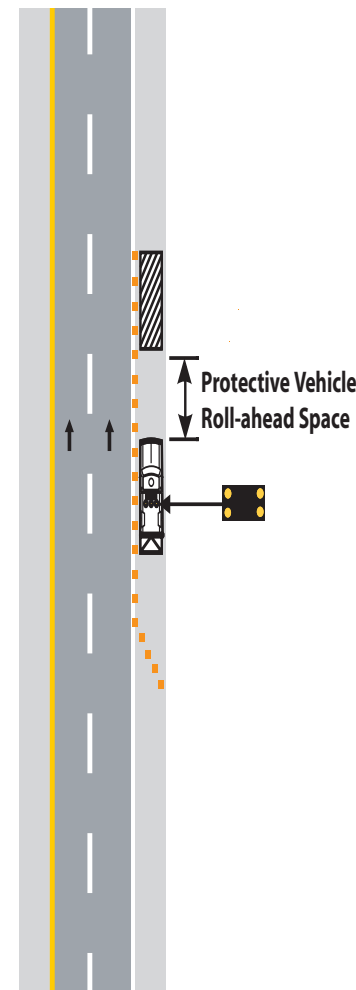
Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-Lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Recommended	Recommended
Multi-lane Divided	Required	Required	Recommended

Shoulder Work on Divided Highways

Scenario 4



Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-Lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Recommended	Recommended
Multi-lane Divided	Required	Required	Recommended



Note:

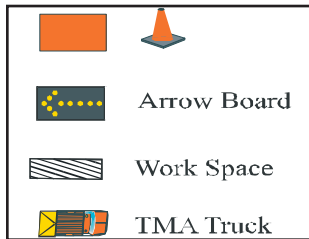
A protective vehicle shall be used while work is in progress. The protective vehicle should be equipped with a TMA and flashing arrow panel and positioned at least 150 feet in the advance warning area of the workspace. The protective vehicle may be eliminated if the roadway is posted at 45 mph or below. The work vehicle is equipped with a flashing arrow panel and uses activated rotating lights and strobe lights.

If the TMA is in a stationary operation, the wheels should be aligned with traffic and the truck should be in neutral with the parking brake set.

In mobile operations, the TMA truck operator should be positioned at least 150 feet in the advance warning area of the workplace and observant to all surrounding conditions. The wheels should be aligned with the traffic.

Lane Closure of Interior Lane on Multi-lane Highway

Scenario 3



Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-Lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Recommended	Recommended
Multi-lane Divided	Required	Required	Recommended

Note:

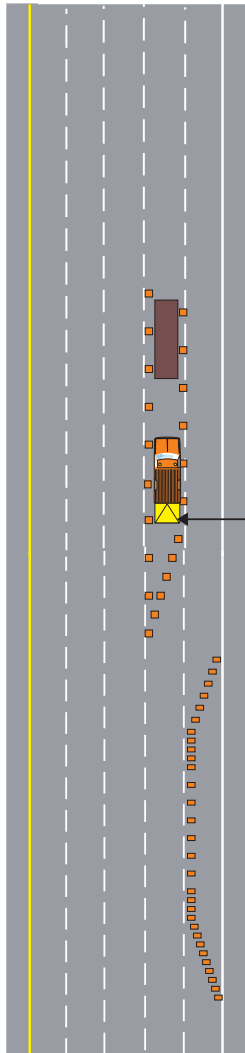
A protective vehicle shall be used while work is in progress. The protective vehicle shall be equipped with a TMA and flashing arrow panel and positioned at least 150 feet in the advance warning area of the workspace. The protective vehicle may be eliminated if the roadway is posted at 45 mph or below. The work vehicle is equipped with a flashing arrow panel and uses activated rotating lights and strobe lights.

If the TMA is in a stationary operation, the wheels should be aligned with traffic and the truck should be in neutral with the parking brake set.

In mobile operations, the TMA truck operator should be positioned at least 150 feet in the advance warning area of the workplace and observant to all surrounding conditions. The wheels should be aligned with the traffic.

When workers are setting channelizing devices, a TMA vehicle shall be used.

Additional protective trucks or TMA's should be used to assist in moving personnel and equipment into interior lanes.



Section 1 - Review Questions

- The qualifications of a TMA driver are:
 - Average intelligence, over 18 years of age, responsible
 - Have a CDL, on probation, and over 18 years of age
 - Be trained in TMA operations and procedures, alert, aware, and observant of the surrounding conditions. Be familiar of daily tasks and be able to apply typical applications
 - Be seat belted in, familiar with the truck, and sleeping at the wheel
- All TMA's should:
 - Meet the National Cooperative Highway Research Project (230 or 350) standards for Truck mounted attenuators
 - Be able to be safely mounted to the rear of a dump truck
 - Be able to withstand a side impact collision.
- The recommended minimum roll ahead distance of a protective vehicle is:
 - 100 feet
 - 150 feet
 - 200 feet
 - 250 feet

Section II – Equipment/Safety Concerns

In most cases when a TMA is required, employees are exposed to high volume, higher speed routes. A TMA is designed to absorb the energy of an errant vehicle. A protective vehicle equipped with a TMA will increase your safety, protect your co-workers, as well as the traveling public.

Seat belts

Seat belt usage is mandatory in a MoDOT owned or leased vehicles. It is extremely important that the driver of a TMA not only wears his/her seat belt, but also must have it adjusted properly.

Properly adjusted seat belts may minimize or reduce injuries. A seat belt should be secured in the manufacturer's locking device and should be snug across the chest.

When a TMA truck has been involved in a crash, the operator should consult with the supervisor and/or the mechanic to see if there's a need to replace the seat belts. A thorough inspection should be conducted by a mechanic or his/her designee to evaluate the integrity of the seat belt and the system associated with it.

Storage of Equipment

A clean truck is vital to the operator's personal safety. The operator of the truck is responsible for making sure that the cab of the truck is cleaned everyday. Removing all trash and debris and securing all loose items will help prevent injury to the operator in the case of a traffic crash.



Mobile Operation on Divided or Multi-lane Highways

Scenario 2

Note:

A protective vehicle occupying any portion of a lane shall be equipped with a flashing arrow panel and a TMA.

A protective vehicle on the shoulder shall be equipped with a flashing arrow panel. This protective vehicle should be equipped with a TMA.

Where adequate shoulder width is not available, Protective Vehicle 2, equipped with a TMA, may drive partially or fully in the lane.

Protective Vehicle 2 shall be equipped with an appropriate lane closure sign. A mounting height of 48 in. from the bottom of the sign to the road surface is recommended.

Protective Vehicle 1 should be positioned at least 150 ft. in advance of the work vehicle. This spacing may be minimized to deter traffic from driving in between the vehicles.

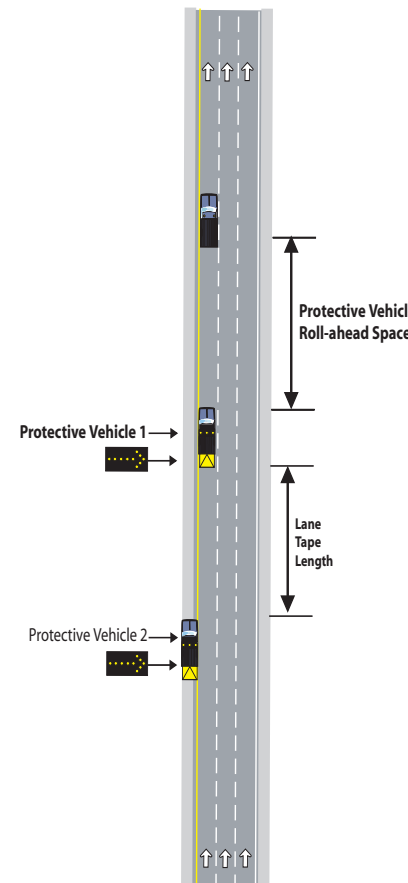
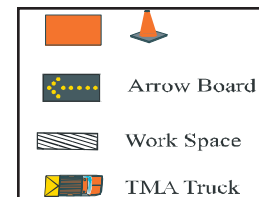
A third protective vehicle (not shown) may be used with Protective Vehicle 1 in the closed lane, Protective Vehicle 2 straddling the edge line, and Protective Vehicle 3 on the shoulder.

For interior lane closure, Protective Vehicles 1 and 2 shall travel in the same lane as the work vehicle. These vehicles shall be separated by at least 150 ft. A double headed arrow shall be displayed on the flashing arrow panels. On high speed roadways, a third protective vehicle should drive the right shoulder. This vehicle shall be equipped with a flashing arrow panel and an appropriate advance lane closure sign and be positioned a distance of T2 from Protective Vehicle 2. The caution mode shall be displayed on the flashing arrow panel. A mounting height of 48 in. from the bottom of the sign to the road surface is recommended.

For mobile operations on roadways posted at 45 mph or below, the protective vehicles and TMAs are optional provided the work vehicle uses activated rotating lights or strobe lights.

For mobile operations moving at a continuous speed within 15 mph of the posted speed and snow operations, the protective vehicles are optional provided the work vehicle uses activated rotating lights or strobe lights.

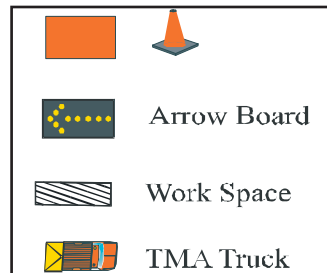
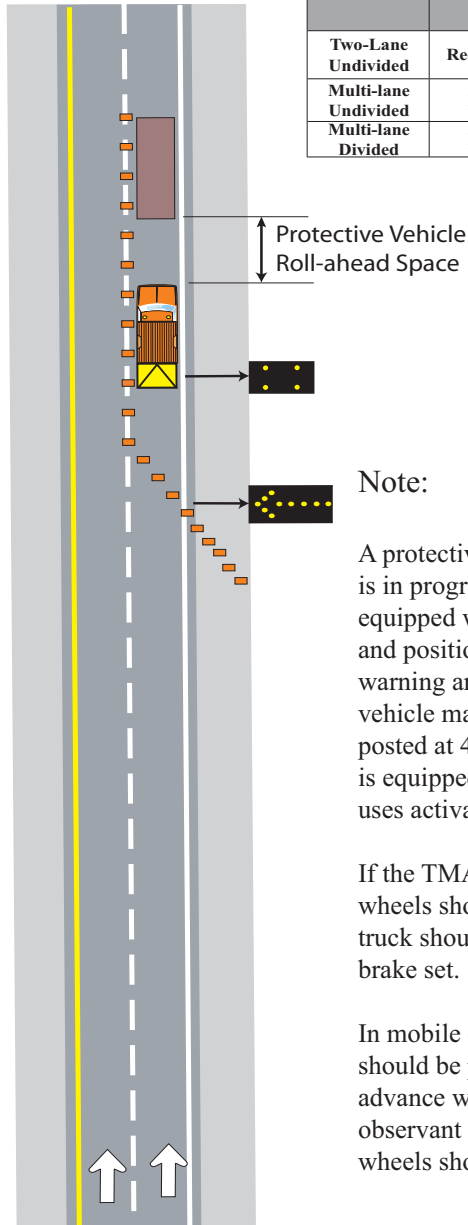
Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-Lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Recommended	Recommended
Multi-lane Divided	Required	Required	Recommended



Lane closure on Multi-lane Highway

Scenario 1

Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-Lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Recommended	Recommended
Multi-lane Divided	Required	Required	Recommended



Note:

A protective vehicle shall be used while work is in progress. The protective vehicle shall be equipped with a TMA and flashing arrow panel and positioned at least 150 feet in the advance warning area of the workspace. The protective vehicle may be eliminated if the roadway is posted at 45 mph or below. The work vehicle is equipped with a flashing arrow panel and uses activated rotating lights and strobe lights.

If the TMA is in a stationary operation, the wheels should be aligned with traffic and the truck should be in neutral with the parking brake set.

In mobile operations, the TMA truck operator should be positioned at least 150 feet in the advance warning area of the workplace and observant to all surrounding conditions. The wheels should be aligned with the traffic.

Important Note: You may be required to store your lunch or other personal items in the cab of the truck. Make sure items are secured inside the cab and not placed on the dashboard, where they can become a projectile.

Enter/Exiting Traffic with a TMA

When you have arrived at the job location, you may be required to switch lanes or move into the desired location.

Always try to have the TMA in the lowered position while in the desired lane, but you may have to have the TMA in the up position until you reach the desired location, then lower the TMA.



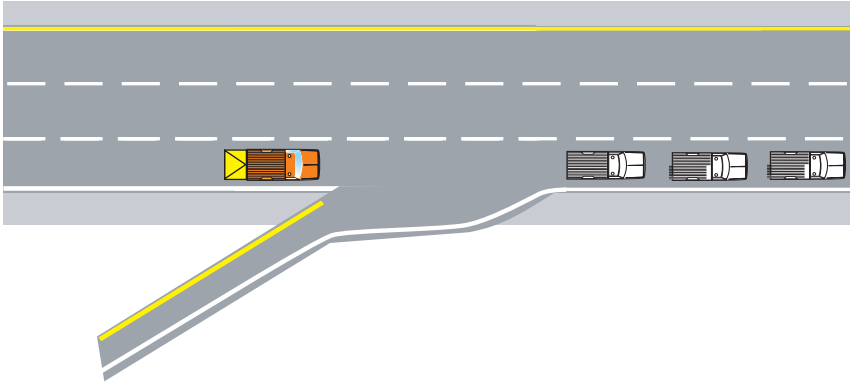
When entering a lane of traffic, the operator should reach the traveling speed and then get into the desired lane of traffic. Once they've reach the desired lane, they should begin to reduce their speed until they reach operational speed or come to a complete stop. For operations where they must come to a complete stop, the operator should be aware of all motorists behind them, in front of them, and those trying to switch lanes.

It may also be required for the TMA truck to get into a desired location and then allow work vehicles, slow moving vehicles, or other work equipment to enter the desired lane in front of them. This will allow traffic to slow down behind the TMA in order for the work vehicle to get to the desired location safely.

Make sure no person or objects are directly behind you while you are lowering the TMA. The TMA should be visible in the mirrors when it is fully in the down position.

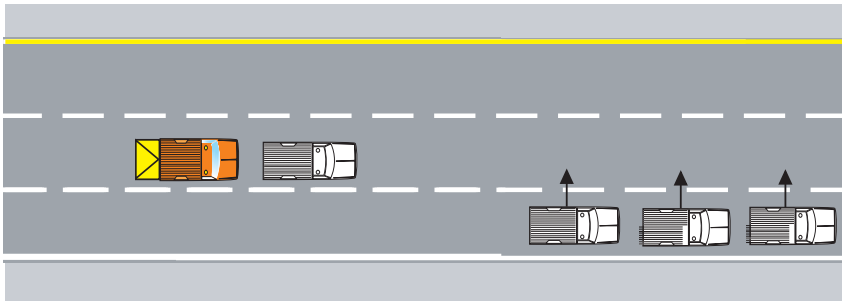
When exiting, check your mirrors to see if any traffic is approaching from behind. When it is safe, begin driving forward while raising the TMA. Do not switch lanes until you know the TMA is in the full upright position.

Diagram 1



When entering a multi-lane highway during high traffic situations, it might be necessary to have a TMA truck positioned so that work vehicles can move in front of the TMA truck.

Diagram 2



The TMA truck should be the first vehicle to get to the desired lane and then allow all other work vehicles to enter the desired lane in front of the rear TMA.

Section IV - Typical Scenarios



Section III – Review Questions

1. Who should inspect chains and/or nylon straps prior to each use:
 - a. Driver
 - b. Supervisor
 - c. Maintenance Supervisor
 - d. Qualified person
2. When an arrow board is used it should be:
 - a. Sighted and aligned with approaching traffic
 - b. Turned off or covered
 - c. Dimmed during daytime operations

Aligning Wheels

The wheels of the TMA should be aligned so they are parallel with traffic at all times. The emergency brake shall be set and the transmission put into neutral during stationary operations.

Having the wheels parallel with traffic, allows the protective vehicle to roll-ahead with traffic. Provide adequate roll-ahead space of approximately 150 feet depending on hills, curves, or other sight distance items that might be present.

Checking Mirrors

Mirrors are vital to the safe and successful operation of a commercial vehicle since they allow the driver to see behind the vehicle.

Auxiliary or convex mirrors give a larger field of view; however, they may distort the driver's perspective by making objects appear smaller and farther away than they actually are.



Important Note: As a TMA driver, you should be aware of the activity going on in front of you, to the sides of you, and behind you. Continuously checking the mirrors will ensure your safety as well as the safety of your crew members, and the traveling public.

Rotation of Drivers

When practical, drivers should be rotated throughout the day. Inattention, mental fatigue, and daydreaming may occur when a driver is in the TMA for long periods of time.

Supervisors need to be aware of these variables and rotate drivers when feasible to eliminate some of the human factors. Having fresh, attentive employees in the TMA truck during moving operations will maximize the driver's safety as well as the employees working in or around the TMA truck.

Emergency Planning

Having an emergency plan and an escape route should be a priority each time you start a new task or move to a new job location. Things that you should know:

- ✓ Who will you call if someone hits the TMA or truck?
- ✓ Who is responsible for all crew members?
- ✓ Is someone trained in First Aid/CPR?
- ✓ Is the scene safe or am I creating another hazard?
- ✓ Are incident/accident forms located within the TMA truck?



If an Incident/Accident Occurs

Your first call should be to your District's Customer Service Center, the second to your supervisor. Be sure to give the customer service representative:

- ✓ Your exact location
 - Use mile markers
 - Exit ramps/numbers
 - Direction you were traveling
 - County in which you are located in
- ✓ Description of incident or traffic crash
- ✓ Number of vehicles involved
- ✓ Type of emergency services needed (EMT, Paramedic, Fire Department, HazMat Crew, etc.)
- ✓ Complete all required Risk Management forms



When closing multiple lanes, a separate unit shall be used to close each lane.

Important Note – The flashing arrow panel should be in the caution mode until the TMA truck has reached its desired location or lane. Once the TMA truck has reached the desired lane, the directional arrow should be displayed.

For moving lane closures on two-lane, undivided highways, the panel shall be deployed within the lane to be closed.

For moving lane closures on multi-lane highways, one panel should be deployed on the shoulder and another shall be deployed within the lane to be closed. Where adequate space does not permit deployment of the unit on the shoulder, the unit may be positioned partially in the lane to be closed.

When an interior lane is being closed by itself, two units shall be deployed within the lane to be closed. When closing multiple lanes, a separate unit shall be used to close each lane.

Important Note: When deployed, the panel shall be sighted and aligned with approaching traffic to ensure visibility of the display.

When roading a flashing arrow panel out to your work location, the unit should be in the down position, if unit can be lowered.



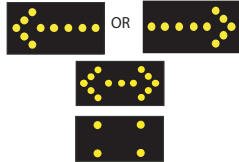
Flashing Arrow Panels

Flashing arrow panels are temporary traffic control devices that provide warning and directional information to assist drivers through or around a temporary traffic control zone.

The overall dimensions of the panel arrow board are 60 inches wide by 30 inches high for truck-mounted units. Flashing arrow panels shall include 15 yellow elements.

Flashing arrow panels may be operated in one of three operating modes:

- Arrow
- Double arrow
- Caution



The **arrow mode** is used when traffic has no choice but to go left or right.

The **double arrow mode** is used when traffic has a choice to go right or left.

The **arrow and double arrow modes** are used for stationary or moving lane closures on multi-lane highways.

The **caution mode** is used for shoulder work, blocking the shoulder, work within a lane when the lane is not closed, and lane closures on two-lanes, undivided highways. When used during night operations, these displays shall be dimmed by 50 percent, (if applicable).

For stationary lane closures, the panel should be deployed on the shoulder or within an adjacent closed lane at the beginning of the lane or one-lane, using a two-way taper. Where adequate, space or the temporary traffic control plan does not permit this placement; the unit may be placed within the taper of the closed lane.



Removing a TMA from the Scene

When preparing to remove a damaged TMA from the scene, consider the following:

- ✓ Is additional equipment needed to cleanup the scene?
- ✓ Can the TMA cartridge be loaded onto a trailer or into the back of another truck bed?
- ✓ Strap the TMA together using MoDOT's approved slings/straps to secure the load.

Important Note: Drivers should use extreme caution when moving a wrecked TMA out of the lane of traffic. The unit may not be adequately attached at the anchor points and should be inspected prior to moving. Loose or broken parts should be secured before the TMA unit is moved.

Returning to Work

How an employee reacts to an incident depends on many life style characteristics. Our job is to ensure that every employee is given the chance to deal with situations effectively. MoDOT has options that supervisors and employees should consider:

- ✓ Supervisors and employees should just talk about the incident and debrief to see if anything could have been done differently.
- ✓ Employees can contact the Employee Assistance Program (EAP)
- ✓ Rotate drivers to keep employees out of the "hot-seat" for a long period of time.

Supervisors are encouraged to talk with everyone involved to make improvements and learn from all discussions.

Section II - Review Questions

1. Lunch boxes, cell phones, and personal belongings are to be:
 - a. Stored on the dash board of the truck
 - b. On the seat next to the driver
 - c. Secured inside the truck or on the floor board of the truck
 - d. On the bed of the truck
2. The wheels of the TMA truck should be:
 - a. Aligned with traffic
 - b. Turned to the right
 - c. Turned to the left
3. The driver of the TMA truck should:
 - a. Check his/her mirrors and be aware of activity going on around you
 - b. Check his/her mirrors for vehicles speeding
 - c. Check his/her mirrors for potholes
 - d. Check his/her mirrors for the supervisor to show up on the job site
4. Driver's rotation should occur:
 - a. When the driver falls asleep
 - b. Every 15 minutes
 - c. When practical, throughout the day
 - d. After an incident

Section III – Operational Issues

Storage of the TMA

When the TMA is not en route to a location or is not in use, the safety chains or safety straps should be used to prevent the unit from accidental deployment.



While the unit is in use, the chains or straps should be stowed away in the manufacturer's approved location. This will prolong the life expectancy of the TMA and the cartridges.

A qualified person should inspect the safety chains and/or nylon straps prior to each use.

Markings and Lighting

When a TMA is used during nighttime operations, the person assigned to be the Work Zone Supervisor shall ensure that all lighting has been dimmed according to the MUTCD Specifications for nighttime activities.

The supervisor of the work zone should assign an individual to perform routine inspections of the work zone. This person is responsible for ensuring:

- ✓ Clear and simple messages are provided to the traveling public via message boards
- ✓ All signs are retroflective and in operational condition
- ✓ A safe work environment is provided for employees
- ✓ Work crews do not blind motorists with area work lighting. (Lights from a pickup are not acceptable work lights.)
- ✓ Adequate roll-ahead distance is provided – at least 150 feet
- ✓ The traveling public is doing what we expect/intend for them to do (i.e., merge, move into/out of lanes, proceed with caution, etc.)